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TERRITORY OF HAWAII

Board of Agriculture and Forestry

DIVISION OF ENTOMOLOGY

DAVID T. FULLAWAY, Entomologist

REPORT

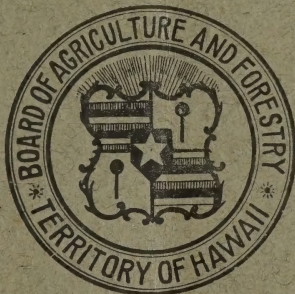
OF THE

Division of Entomology

FOR THE

Biennial Period Ended December 31, 1920

Reprint from the Report of the Board of Commissioners
of Agriculture and Forestry



HONOLULU, HAWAII
ADVERTISER PUBLISHING CO., LTD.
1921

Officers and Staff of the Board of Commissioners of Agriculture and Forestry

1920

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DIVISION OF ENTOMOLOGY

DAVID T. FULLAWAY, Entomologist.

QUAN CHEW, Laboratory Assistant.

RODRIGO VILLAFLORES, Insectary Assistant.

NOTICE.

The Division of Entomology furnishes information in regard to insects, and is prepared to aid with advice and directions anyone seeking relief from insect depredations, without charge. Solicitation can be made in person or by mail. Where a personal examination cannot be made by the Entomologist and the nature of the injury is obscure, specimens of the destructive agent are requested. These may be sent through the mails as first-class matter or by parcels-post, and should be packed in stout containers which will not be broken or come apart in transit. The package should bear the name and address of the sender on its face in the upper left-hand corner, and should be accompanied by a letter describing the circumstances as far as possible.

The Division also aims to keep on hand a supply of beneficial insects and to furnish them on request.

Address communications to the Entomologist, Board of Agriculture and Forestry, P. O. Box 207, Honolulu, Hawaii.

D. T. FULLAWAY, Entomologist.

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DIVISION OF ENTOMOLOGY

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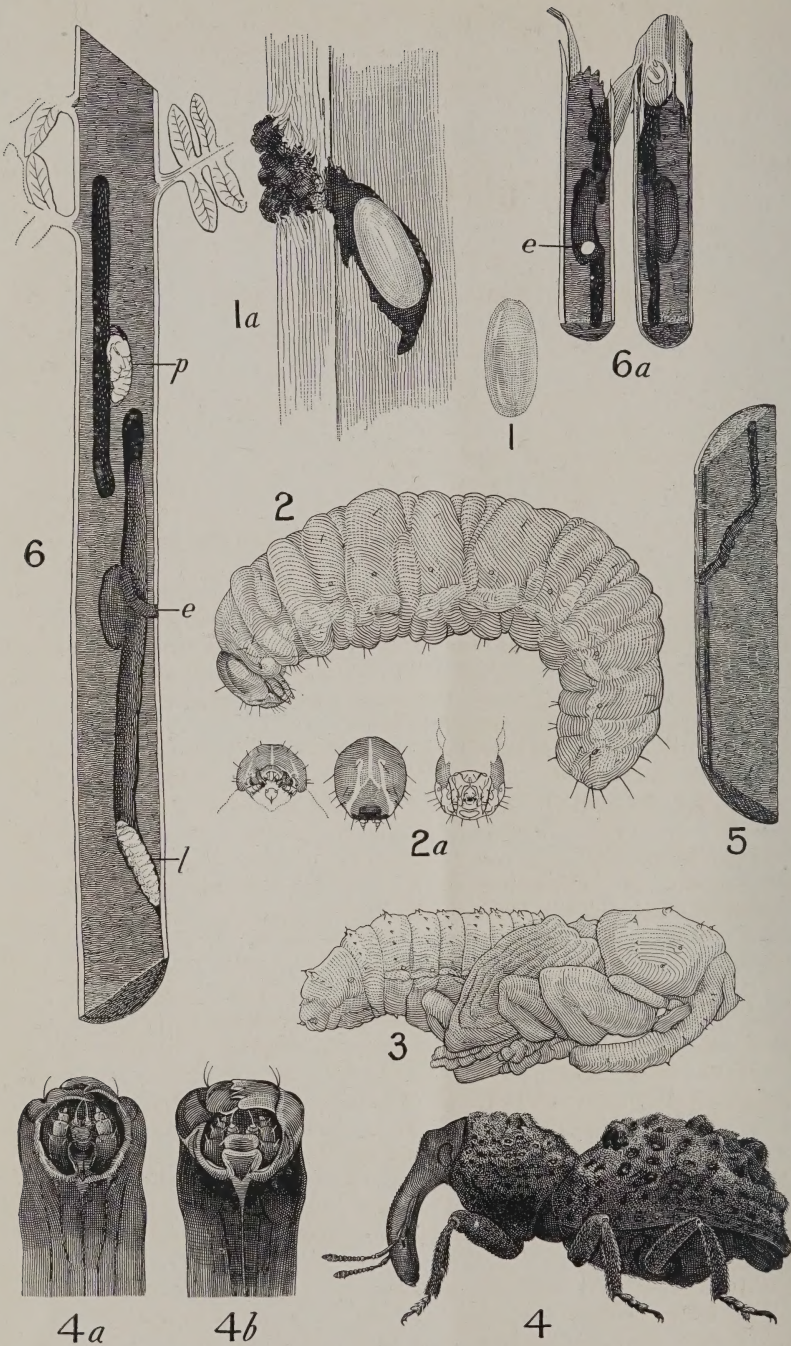


Plate XIII.—Legend.

The Fern Weevil (*Syagrius fulvitaris* Pasc.)—1, egg (greatly enlarged); 1a, section of fern stem showing egg-chamber (greatly enlarged). 2, larva; 2a, head of larva from front, above, and beneath, showing mouth parts (x10). 3, pupa (x10). 4, adult weevil (x10); 4a, b, apical extremity of rostrum showing mouth parts (greatly enlarged). 5, section of fern stem showing gallery of freshly-hatched larva (somewhat enlarged). 6, section of fern stem showing galleries of more advanced larvae and pupal chamber with exit; l, larva; p, pupa; e, exit (somewhat enlarged); 6a, portion of the preceding in greater detail.

Division of Entomology

REPORT OF THE ENTOMOLOGIST

Honolulu, Hawaii, December 8, 1920.

Board of Commissioners of Agriculture and
Forestry, Territory of Hawaii.

Gentlemen: I submit herewith my report for the biennial period January 1st, 1919, to December 31st, 1920:

The activities of the Division of Entomology during the biennial period ended December 31, 1920, have been largely directed along practical lines, aiming to meet the demand for relief from insect depredations. A great deal of time, however, has been given to investigation, and the most pressing problems of insect control have been thoroughly studied.

The propagation and distribution of beneficial insects, particularly fruit-fly, horn-fly and corn leaf-hopper parasites, have been continued throughout the period. A tabulation of the data in connection with this work is appended.

The acclimitization and establishment in the islands of *Pteromalus puparum*, an important pupal parasite of one of the destruction cabbage insects *Pieris rapae* (cabbage worm, imported cabbage butterfly) was again tried. A small consignment of the parasite was received through the cooperation of the California State Horticultural Commission in June, 1919, and instead of liberating the parasites at once as had been done on previous occasions, they were held for multiplication by rearing in confinement. It has thus been possible to liberate large numbers of individuals at frequent intervals of time and in many different localities. A tabulation of the data in connection with this work is also appended. To date the parasite has not been recovered in the field, but its ultimate establishment is confidently expected. Assurance of the establishment of several earlier introductions, notably the cockroach parasite, *Dolichurus stantoni*, has been gained during the biennial period.

In September, 1919, an infestation of the forest ferns by the Australian Fern Weevil, *Syagrius fulvitaris*, was discovered at 29 Miles from Hilo on the Hilo-Kau Road. On account of the wealth of fern growth in this region and the importance of the ferns as part of the ground cover in the nearby forest reserves, it was decided to attempt to control the outbreak and prevent the

spread of the weevil beyond the confines of the small area in which it was determined to be present. This necessitated the destruction of all ferns in the area as far as possible, which were cut and burned. Thereafter the ground cover was either fired or poisoned as far as possible to destroy crawling weevils which might have escaped the initial treatment, and to remove the last vestige of subsistence for the weevils. An artificial barrier of crude oil was also laid on the outer edge of the infestation, to contain the insect. Unfortunately the work was hampered by property holders in the infested area, who found the drastic requirements of the eradication work very burdensome. Delays for this and other reasons led to the involvement of such a large territory that the cost of clearing seemed to go beyond reasonable limits, and the work was terminated without the achievement of a complete eradication, although at the time of abandonment success seemed probable and easily within reach.

On account of unsettled conditions abroad and poor transportation facilities no field work was undertaken until the latter part of 1920, when the failure of artificial control measures applied to the fern weevil turned the minds of those interested in the direction of natural or biological control, and in September steps were taken to employ an entomologist in Australia to investigate the biology of the fern weevil with respect to its natural enemies. At about the same time a cooperative arrangement was made with the H. S. P. A. Experiment Station for the development of several projects which had been under consideration for a long time, namely, the introduction of parasites of the bean pod borer *Lycaena boetica*, the improvement of dung fly control, and the introduction of the insects producing fertile seeds in trees of the genus *Ficus* which are desirable for purposes of reforestation.

Two important investigations have been carried on during 1920 the results of which are about to be published. In connection with the control of the fern weevil a thorough study was made of its history, habits, cyclical development, etc., which had not previously been done, although the weevil has been known in the islands fifteen years. Later the termites, or white ants, which damage wood, woodwork and wood products were given consideration.

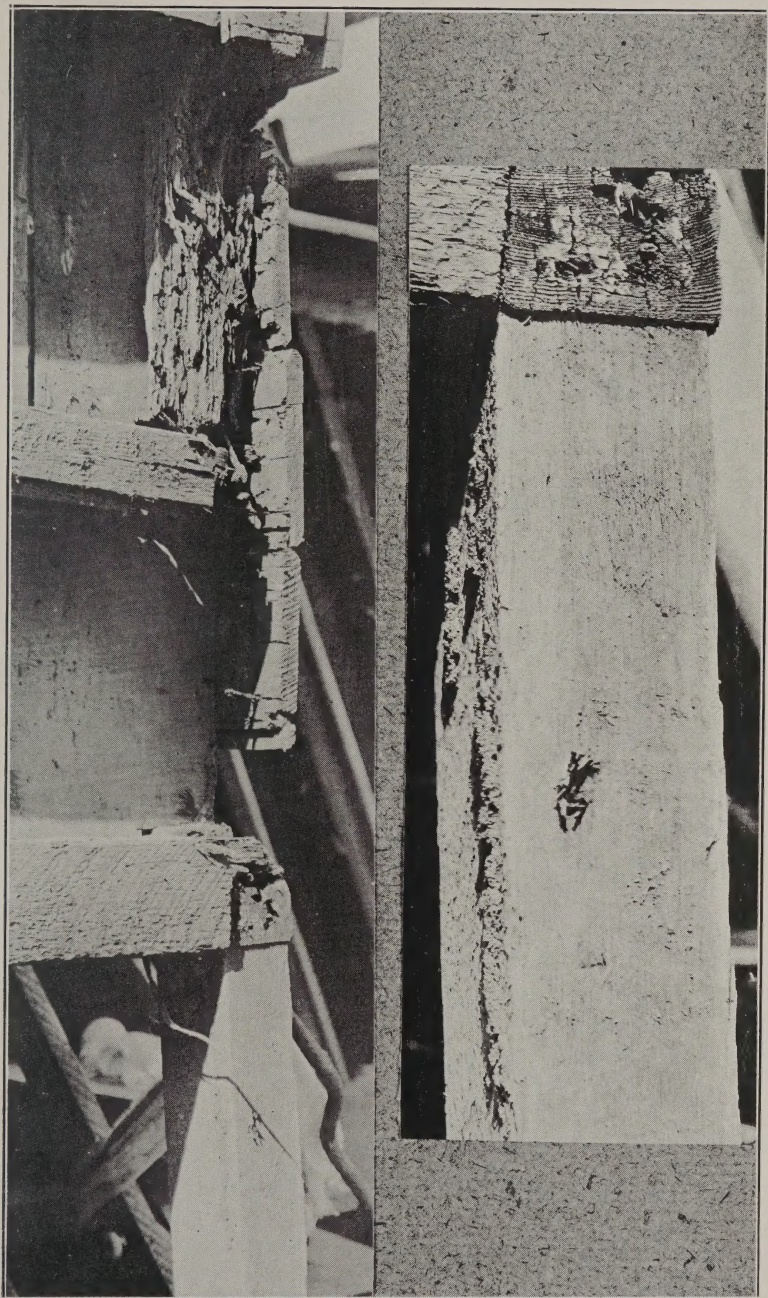
The regular routine of advising in regard to agricultural and stock pests, maintenance of collections and classificatory work on the same, has also been attended to. The following publications have been made:

Natural Control of Scale Insects in Hawaii:

—P. H. E. S. V. IV (2), June, 1920. (pp. 237-246).

New Genera and Species of Braconidae, Mostly Malayan:

—Jour. Straits Branch R. A. Soc., No. 80, 1919. (pp. 39-59,
1 pl.)



Work of the white ant, *Coptotermes intrudens* Oshima. Runway constructed on supporting timber and leading from underground nest to framework of dwelling-house in Honolulu. (Reduced.)

Control of the Melon Fly in Hawaii by a Parasite Introduced from India:

—Rpt. of the Proc. of the Third Ent. Meeting held at Pusa, India, Feb. 1918. Reprinted Haw. For. and Agr., Vol. XVII (4), April, 1920. (pp. 101-105).

The Fern Weevil Menace:

—Haw. For. and Agr., Vol. XVII (1), p. 3-4, 1 pl., Jan., 1920.

The Horn-Fly Problem:

—Haw. For. and Agr., XVII (6), June, 1920. (pp. 166-167).

Termites, or White Ants, in Hawaii:

—Haw. For. and Agr., Vol. XVII (10), Oct., 1920. (pp. 294-301, 10 pls).

The Fern Weevil (*Syagrius fulvitaris*):

—In course of preparation.

Respectfully submitted,

DAVID T. FULLAWAY,
Entomologist.

TABULATION SHOWING THE LIBERATION OF BENEFICIAL
INSECTS, 1919-1920.

	Oahu	Kauai	Molokai	Maui	Hawaii	Total
FRUIT FLY						
PARASITES.*						
<i>Galesus silvestri</i>	18,830	....	....	....	....	18,830
<i>Diachasma tryoni</i>	18,270	650	....	2,200	855	21,975
<i>Tetrastichus giffardianus</i>	38,275	500	....	3,050	2,100	43,925
<i>Dirhinus giffardi</i>	9,990	....	....	....	....	9,990
<i>Opius humilis</i>	8,110	....	....	790	....	8,900
<i>Diachasma fullawayi</i>	6,345	200	....	1,460	50	8,055
Totals	99,820	1,350	....	7,500	3,005	111,675
MELON FLY						
PARASITE.†						
<i>Opius fletcheri</i>	82,910	650	400	450	8,150	92,560
CORN LEAF						
HOPPER PARASITE.‡						
<i>Paranagrus osborni</i>	88,100	33,100	7,000	2,000	29,500	159,700
DUNG FLY						
PARASITES.§						
<i>Spalangia cameroni</i>	11,550	....	....	2,350	....	13,900
<i>Pachycrepoides dubius</i>	150	....	....	....	....	150
Totals	11,700	....	....	2,350	....	14,050

*Liberated at:

Oahu: Nuuanu, Kaimuki, Moanalua, Waipahu, Makiki, Kalihi, Pearl Harbor, Pupukea, Wyllie Street, Manoa, Wahiawa, Waikiki, Palama.

Hawaii: Kohala, Kamuela, Honokaa, Hilo, Pepeekeo, Hawi.

Maui: Wailuku, Paia, Kula, Makawao.

Kauai: Kalaheo, Kealia.

†Liberated at:

Oahu: Moiliili, Manoa, Lualualei, Makiki, Kaaawa, Ft. Kamehameha, Wahiawa, Kailua, Pearl Harbor, Maunawai, Pupukea, Nuuanu, Kalihi, Waiialua, Moanalua, Waipahu, Kaneohe, Waianae.

Hawaii: Hilo, Kamuela, Pepeekeo, Glenwood, Kapoho, Paaui, Keaau.

Maui: Wailuku, Makawao.

Kauai: Kealia.

‡Liberated at:

Oahu: Makiki Nursery, Kalihi, Manoa, Wahiawa, Kailua, Schofield Barracks, Kaneohe.

Hawaii: Kohala, Hawi, Kamuela.

Kauai: Lihue, Kealia, Kilauea.

Maui: Kula.

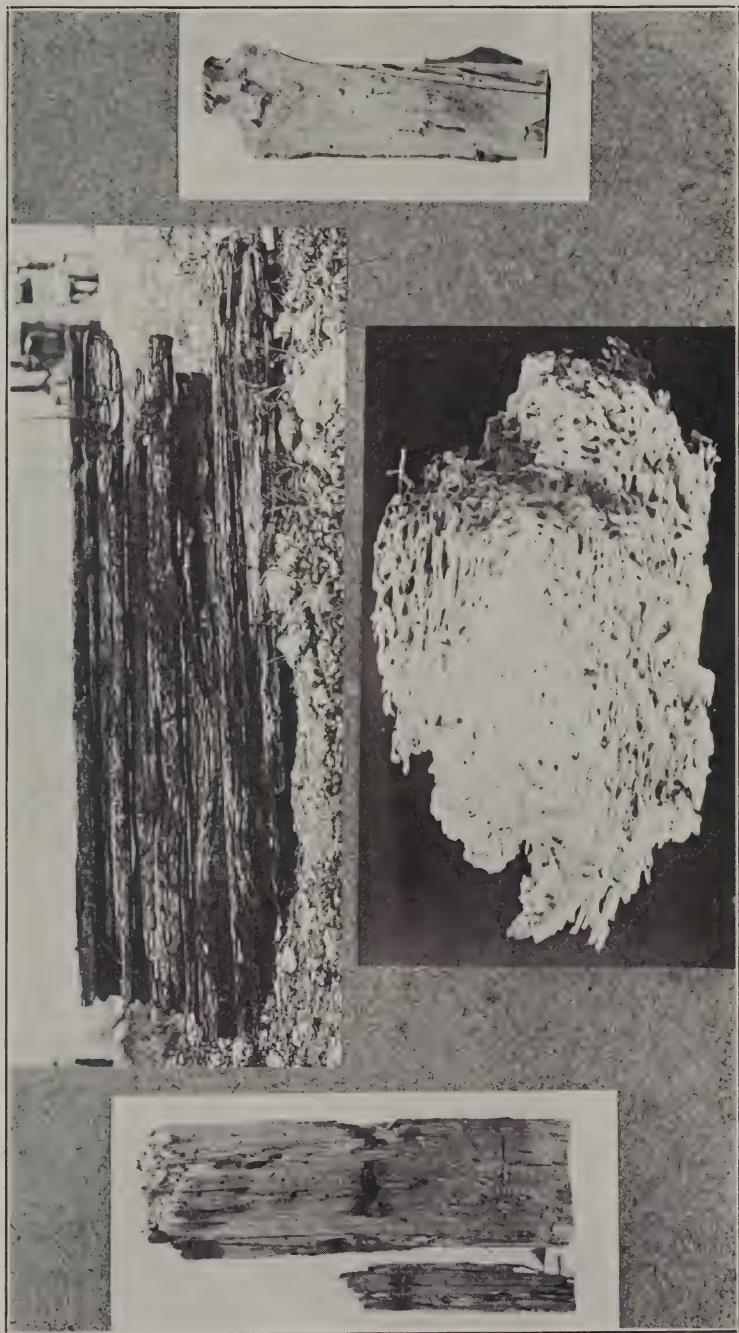
Molokai: Pukoo.

§Liberated at:

Oahu: Wahiawa, Maunawai, Moanalua, Pearl Harbor.

Hawaii: Volcano House, Keaau.

Maui: Paia.



Work of the three lowland species of white ants or termites in Hawaii. Center—*Coptotermes intrudens* Oshima, damaged railroad sleepers, above; interior of damaged timber, below. Left—*Kaloterms* sp. referred to *marginipennis*—damaged timber. Right—*Cryptoterms* sp. referred to *brevis*—damaged wood sample. (Reduced.)

TABULATION SHOWING REARING, LIBERATION AND DISTRIBUTION OF PTEROMALUS PUPARIUM, PUPAL PARASITE OF THE CABBAGE BUTTERFLY, PIERIS RAPAE.

1919-1920.

Month	Pupae	Emergence	Liberation
1919—			
June	27	.....	.....
July	112	989	679
August	176	3,610	1,200
September	372	7,353	5,800
October	524	10,740	8,300
November	981	20,286	19,900
December	549	18,458	16,400
Total	<u>2,741</u>	<u>61,436</u>	<u>52,279</u>
1920—			
January	518	7,292	6,300
February	610	20,436	18,700
March	568	27,195	26,150
April	364	9,875	10,200
May	287	10,112	99,100
June	38	347	250
July	89	2,277	1,800
August	232	7,865	6,050
September	319	8,870	8,100
October	362	11,760	11,200
November	253	5,615	5,500
December	216	3,340	4,000
Total	<u>3,856</u>	<u>114,984</u>	<u>107,350</u>

Liberated at the following localities:

Oahu: Wahiawa, Makiki, Moiliili, Koko Head, Waikiki, Kalihi, Moanaiua, Pearl City, Nuuanu, Punahou.

Hawaii: Kamuela, Kealahakua, Hilo.

Molokai: Kalaupapa.

Board of Agriculture and Forestry

PUBLICATIONS FOR DISTRIBUTION, 1921.

Any one or all of the publications listed below (except those marked *) will be sent to residents of this Territory, free, upon application to Mailing Clerk, P.O. 207, Honolulu, Hawaii.

BOARD

- *Reports of the Commissioner of Agriculture and Forestry for 1900 and 1902, and First Report of the Board of Commissioners of Agriculture and Forestry, 1904. Reports of the Board of Commissioners of Agriculture and Forestry for the years 1905, 1906, 1907, 1908, and biennial periods 1910, 1912, 1914, 1916, 1918, 1920.
- "Notice to Importers," by H. E. Cooper; 4 pp.; 1903.
- "Digest of the Statutes Relating to Importation of Soils, Plants, Fruits, Vegetables, etc., into the Territory of Hawaii," General Circular No. 1; 6 pp.
- "Important Notice to Ship Owners, Fruit Importers and Other Rules and Regulations Prohibiting the Introduction of Certain Pests and Animals into the Territory of Hawaii," General Circular No. 2; 3 pp.; 1904.
- "Laws and Regulations, Importation and Inspection of Honey Bees and Honey," General Circular No. 3; 7 pp.; 1908.
- Act 71, Session Laws of 1905: "To Provide for the Protection of Forest Land Within the Territory from Fire." On Brush-Burning Permit Form; 1905.
- Act 104, Session Laws of 1907: "To Provide for the Protection of Birds Beneficial to the Forests of the Territory of Hawaii." Unnumbered leaflet; 1907.
- Pure Seed Law, Act 107, Session Laws of 1911: "To Regulate the Importation and Sale of Seed Into and Within the Territory of Hawaii." Unnumbered leaflet, 4 pp.; 1911.
- "The Hawaiian Forester and Agriculturist," a monthly magazine. Vols. I to XVII; 1904-1920. To be obtained from the Advertiser Publishing Co., Ltd., Honolulu, Hawaii. Price, \$1.00 a year. (Issued under the auspices of the Board.)

DIVISION OF FORESTRY

- "Eucalyptus Culture in Hawaii," by Louis Margolin. Bulletin No. 1; 88 pp.; 12 plates; July, 1911.
- "An Offer of Practical Assistance to Tree Planters." Circular No. 1; 6 pp.; 1905.
- "Instructions for Propagating Forest, Shade and Ornamental Trees," by David Haughs; Circular No. 2; 11 pp.; June, 1912. Reprinted, May, 1915.
- "Forest and Ornamental Tree Seed for Sale at Government Nursery." Press Bulletin No. 1; 3 pp.; 1905.
- "Suggestions in Regard to the Arbor Day Tree Planting Contest." Press Bulletin No. 2; 7 pp.; 1905.
- "Revised List of Forest and Ornamental Tree Seed for Sale at the Government Nursery." Press Bulletin No. 3; 4 pp.; 1906.
- "Instructions for Propagating and Planting Forest Trees." Press Bulletin No. 4; 4 pp.; 1906.
- "Instructions for Planting Forest, Shade and Ornamental Trees." Press Bulletin No. 5; 7 pp.; 1909.
- "Na Hoakaka no ke Kanu ana i na Laau Hoomalu ame na Laau Hoohiwahiwa." Press Bulletin No. 6; 8 pp.; 1909.
- Rule II: "Concerning the Protection and Administration of Forest Reserves"; unnumbered leaflet; April, 1916.
- Rule III: "Concerning Trespassing on the Honolulu Watershed"; unnumbered leaflet; April, 1916.
- Rule IV: "Concerning the Protection of Bird, Animal and Vegetable Life on Certain Islands of the Territory"; unnumbered leaflet; July, 1917.
- "Forestry as Applied in Hawaii," by C. S. Judd. Reprint from "The Hawaiian Forester and Agriculturist," Vol. XV, No. 5; 17 pp.; 4 plates; May, 1918.

Reports

Reports of the Division of Forestry for the years ending December 31, 1905, 1906, 1907, 1908, and biennial periods 1910, 1912, 1914, 1916, 1918, and 1920.

Botany

- "New and Noteworthy Hawaiian Plants," by Dr. L. Radtkoffer and J. F. Rock. Botanical Bulletin No. 1; 15 pp.; 6 plates; September, 1911.
- "List of Hawaiian Names of Plants," by J. F. Rock. Botanical Bulletin No. 2; 20 pp.; June, 1913.
- "The Sandalwoods of Hawaii," by J. F. Rock. Botanical Bulletin No. 3; 43 pp.; 13 plates; December, 1916.
- "The Ohia Lehua Trees of Hawaii," by J. F. Rock. Botanical Bulletin No. 4; 76 pp.; 31 plates; August, 1917.
- "The Aborescent Indigenous Legumes of Hawaii," by J. F. Rock. Botanical Bulletin No. 5; 53 pp.; 18 plates; June, 1919.
- "The Hawaiian Genus Kokia, A Relative of the Cotton," by J. F. Rock. Botanical Bulletin No. 6; 22 pp.; 7 plates; June, 1919.

*This Bulletin will be sent only to persons interested in the subject.

*Out of print.

PUBLICATIONS FOR DISTRIBUTION—(Continued).

DIVISION OF ENTOMOLOGY

- "The Leaf-Hopper of the Sugar Cane," by R. C. L. Perkins. Bulletin No. 1; 33 pp.; 1903.
- "A Catalogue of the Hemipterous Family Aleyrodidae," by G. W. Kirkaldy and Jacob Kotinsky. Bulletin No. 2; 102 pp.; 1 plate; 1907.
- "Report of an Expedition to Africa in Search of the Natural Enemies of Fruit Flies," with Descriptions, Observations and Biological Notes, by F. Silvestri. Bulletin No. 3; 176 pp.; 26 plates; 1914.
- "The Corn Leaf Hopper," by D. T. Fullaway. Bulletin No. 4; 16 pp.; 18 figs; 1918.
- "On Some Diseases of Cane Specially Considered in Relation to the Leaf Hopper Pest and to the Stripping of Cane," by R. C. L. Perkins. Press Bulletin No. 1; 4 pp.; 1904.
- "A Circular of Information," by Jacob Kotinsky. Circular No. 1; 8 pp.; 1905.
- "The Japanese Beetle Fungus," by Jacob Kotinsky and Bro. M. Newell. Circular No. 2; 4 pp., cuts; 1905.
- "Mediterranean Fruit Fly (*Ceratitis capitata*)", by E. M. Ehrhorn. Circular No. 3; 7 pp.; 2 plates; 1912.

Reports

Reports of the Division of Entomology for the years, ending December 31, 1905, 1906, 1907, 1908 and biennial periods 1910, 1912, 1914, 1916, 1918, and 1920.

DIVISION OF PLANT INSPECTION

- Rule I: "Concerning the Importation of Fruits, Plants, etc." Unnumbered leaflet; amended June 8, 1918; further amended, October 31, 1919.
- Rule III: "Concerning the Importation of Rice." Unnumbered leaflet, amended June 8, 1918.
- Rule VII: "Concerning the Prevention of Distribution of the Mediterranean Fruit Fly." Unnumbered leaflet; November 21, 1910.
- Rule VIII: "Concerning the Importation of all Banana Fruit, Shoots or Plants." Unnumbered leaflet; January 25, 1911.
- Rule IX: "Concerning the Prevention of Distribution of Insect Pests from Oahu to the Other Islands." Unnumbered leaflet; June 28, 1911.
- Rule XII: "Concerning the Control of Insects and Plant Diseases in the Territory of Hawaii." Unnumbered leaflet; December 30, 1911; amended May 26, 1920.
- Rule XVIII: "Concerning the Control of Fungus Diseases on Pineapples, Island of Kauai." Unnumbered leaflet; May, 1913; amended to include Island of Oahu; June, 1914; amended further on September 2, 1916; amended further July 18, 1919.
- Rule XIX: "Concerning the Introduction of Pineapple Plants, etc." Unnumbered leaflet; June 8, 1918.
- Rule XX: "Concerning the Control of Insect Pests and Plant Diseases." Repealing Rule XVII. Unnumbered leaflet; June 1, 1919; amendment to Section 5; June 1, 1920.
- Rule XXI: "Concerning the Control of Certain Insect and Plant Pests." Unnumbered leaflet; February 25, 1920; amended May 7, 1920.
- Rule XXII: "Concerning the Importation into the Territory of Hawaii of Potatoes and Apples from Pacific Coast Ports." Unnumbered leaflet; May 26, 1920.

Reports

Report of the Division of Plant Inspection for the biennial periods 1918 and 1920.

DIVISION OF ANIMAL INDUSTRY

- "Inspection of Imported Live Stock." Rule 1; 1 p.; 1905.
- "Inspection and Testing of Imported Live Stock for Glanders and Tuberculosis." Rule 2; 1 p.; 1905.
- "Concerning Glandered Horse Stock in the Territory." Rule 3; 1 p.; 1905.
- "To Amend Rule 1, Inspection of Imported Live Stock." Rule 4; 1 p.; 1907.
- "Quarantine of Horse Stock from California." Rule 8; 1 p.; 1908.
- "Rules and Regulations, Inspection and Testing of Live Stock Intended for Importation." Rules I to V and Laws; 11 pp.; unnumbered pamphlet. Effective January 1, 1910; replaces earlier rules.
- Rule VI: "Concerning the Quarantine of Dogs for Rabies"; 2 pp.; unnumbered leaflet; 1912.
- Rule VII: "Concerning the Shipment of Hogs from the Island of Oahu to any Other Island in the Territory of Hawaii"; unnumbered leaflet; July, 1913.
- Rule IX: "Concerning Hog Cholera and Other Diseases of Swine," unnumbered leaflet; August, 1916.
- "The Treatment and Prevention of Sore-Head, or Chicken Pox, by Means of Vaccination," by V. A. Norgaard. Circular No. 1; 5 pp.; February, 1916.
- "Regulations Governing the Importation of Live Stock and other Animals into the Territory of Hawaii." (Rules I-X). Effective June 8, 1918. Circular, 9 pp. Rule VIII amended November 6, 1920.
- Rule XIV: "Concerning Inter-Island Shipment of Dairy Cattle Affected with Tuberculosis." Effective February 25, 1920.

Reports

Reports of the Division of Animal Industry for the years ending December 31, 1905, 1906, 1907, 1908, and biennial periods 1910, 1912, 1914, 1916, 1918, and 1920.

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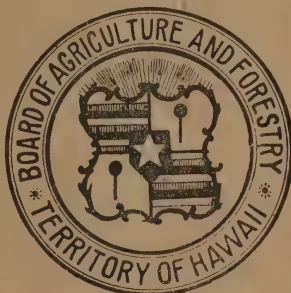
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The Division also aims to keep on hand a supply of beneficial insects and to furnish them on request.

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D. T. FULLAWAY, Entomologist.

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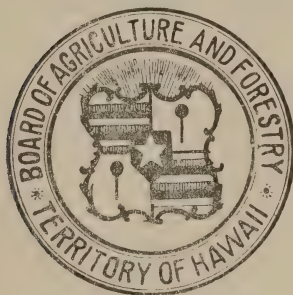
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Division of Entomology

REPORT OF THE ENTOMOLOGIST

Honolulu, Hawaii, January 1, 1923.

Board of Commissioners of
Agriculture and Forestry,
Honolulu, Hawaii:

Gentlemen: I am gratified to be able to report as follows on the activities of the Division of Entomology in the biennial period January 1, 1921, to December 31, 1922.

PROPAGATION AND DISTRIBUTION OF BENEFICIAL INSECTS.

The propagation and distribution of beneficial insects, particularly the fruit-fly, horn-fly, cornleaf-hopper and cabbage-worm parasites and predators, have been continued throughout the biennial period, and a tabulation which follows, gives the numbers of the different species liberated, according to islands, with references to place of liberation.

ROUTINE WORK.

The routine work of advising in regard to agricultural and stock pests and their control, the maintenance of the insect collections, etc., have also been faithfully performed.

PROJECTS.

Five major projects, however, have engaged most of the time and attention of the Division, namely, 1. The investigation of the possibilities connected with the introduction and colonization of the caprifying insects associated with the various species of fig trees (*Ficus spp.*) growing in Hawaii, as an aid to forestry; 2. The search for, introduction and colonization of various insects likely to aid in the control of the horn-fly; 3. A study of the insects infesting the pineapple plant, with regard particularly to the possibility of controlling the most injurious species by natural and artificial agencies;

4. The search for, introduction and colonization of the natural enemies of some of our economically important mealy-bug species; 5. Army-worm control by natural and artificial means.

FIG INSECT INVESTIGATIONS.

The fig insect investigations were undertaken in coöperation with the botanists and entomologists of the Hawaiian Sugar Planters' Association, and included in their scope seven species of figs native to the Oriental region, namely, *Ficus retusa*, *F. infectoria*, *F. hispida*, *F. rumphii*, *F. benjamina*, *F. bengalensis*, and *F. elastica*. In the prosecution of these investigations, the entomologist visited Japan, the Philippine Islands, Hong Kong, Singapore and Penang on the Malay Peninsula, and various parts of British India, studying the character of the trees and the relation of the caprifigging insects to them, the periodicity of the insects, and problems of transportation. The insects associated with each species were collected for study and numerous shipments of figs containing living fig wasps were made from Hong Kong while the Entomologist was there, and further shipments arranged for after his departure. Where ripe figs were not obtainable, arrangements were made to have them sent in season.

In this way a shipment of fruiting plants of *Ficus elastica* with insects, obtained by an assistant of the Botanist of the Mysore Government (British India), from the Siligiri district of Assam, where *F. elastica* is indigenous, was received on October 2, 1921, and handled by Mr. Ehrhorn and myself in the quarantine room of the Plant Inspection Department. Unfortunately, nothing resulted from it, the plants proving unable to endure the hard conditions of the long journey over the water from Calcutta.

Another shipment of fruiting plants of *Ficus hispida* with insects was received on August 27, 1922, from the Superintendent of the Hong Kong Botanic Gardens. These were also in poor condition on arrival, but one still bore figs and from 8 of these, 30 fig insects (*Ceratosolen* sp.) were recovered, which were liberated on a large example of *Ficus hispida* in Mrs. Foster's garden, Nuuanu and School Streets, Honolulu. Three consignments of detached figs of *Ficus retusa* from the same source, packed in moss, in cotton-stoppered glass tubes, and shipped in refrigeration, were also received during 1922,

PLATE X.



Fig. 1. Prize Hereford Bull on the Parker Ranch, Hawaii, molested by a swarm of horn flies.



Fig. 2. One of the Tumble Bugs (*Copris colonicus*) imported from Arizona to assist in combating the horn fly scourge.

on March 7, May 13, and October 5 respectively, but no living fig wasps were obtained from any of the lots.

A detailed report of the investigation of fig insects in the Orient appeared in the Hawaiian Forester and Agriculturist for June, 1921. While none of the much desired Oriental species of fig wasps has thus far been established, two species from Australia, fertilizing *Ficus macrophylla* and *Ficus rubiginosa*, obtained by C. E. Pemberton, have been successfully transported and colonized.

HORN-FLY CONTROL.

Shortly after my return from the Orient, in April, 1921, work was resumed on the horn-fly control project, on which little had been done since 1910. Dr. J. F. Illingworth, formerly Professor of Entomology at the University of Hawaii, and more recently Government Sugar Entomologist in Queensland, was employed to investigate the natural agencies limiting the abundance of dung-flies in Australia; and later, Mr. H. T. Osborn, Assistant Entomologist, H. S. P. A. Experiment Station, was engaged to do the same in southwestern United States and Mexico. On the basis of these investigations, shipments were made of the most promising species of parasitic, predaceous and scavenging enemies of the horn-fly, which have been handled at this end by Mr. Muir, Entomologist at the H. S. P. A. Experiment Station, and myself, in the quarantine room of that institution, and after careful sifting and elimination of all undesirable or extraneous material, the required species have been released, in suitable localities, on all the islands. Mr. Illingworth was employed on part time for five months and on full time for three months and made three consignments of material, bringing a fourth lot personally on his return to Hawaii. Mr. Osborn has been continuously engaged since August, 1921, although only part of his time has been spent in securing horn-fly enemies. Seventeen shipments of this sort of material were made by him, consisting for the most part of various species of dung rollers or tumble bugs (*Copriid* beetles). Pl. X Fig. 2. More stress has been put upon the establishment of coprophagous agents than upon parasites or predators, because it is believed the destruction of the dung is the most important element of the problem at the present time. If the number of flies could be reduced fifty per cent by destroying their breeding places, the action of parasites and predators would soon be

appreciated, but otherwise they are not likely to make much impression on a species which breeds so freely in cow manure. In addition to the shipments made by these two entomologists, material of a similar nature was sent in by Messrs. F. X. Williams and C. E. Pemberton, Assistant Entomologists at the H. S. P. A. Experiment Station, whilst investigating wire-worm enemies in the Philippines and Australia respectively.

The species handled thus far have been :

FROM THE PHILIPPINES.

(One shipment)

Onitis phartophus

Catharsius molussus—large copriid beetles.

(Failed to produce in confinement).

Onthophagus sp. as larvae—small copriid.

(Reared to maturity and liberated in Honolulu near Salvation Army Home, Manoa).

FROM AUSTRALIA.

(Four shipments).

Onthophagus pugnax as larvae—large copriid.

(300 reared to maturity and liberated at Wahinekea Station, on the Parker Ranch).

Creophilus erythrocephala—large staphylinid beetle. Fig. 1.



Fig. 1. Large Staphylinid beetle (*Creophilus erythrocephala*) predacious on dung fly maggots.

(Bred in confinement since September, 1921, and liberated in sizable lots on all the islands).

Onthophagus granulatus—small copriid beetle.

Onthophagus sp.

Staphylinidae—several species.

Silphid

Histerid

(Liberated on the Parker Ranch, on the island of Hawaii).

Staphylinid—small, near *Oxytelus*.

(About 100 liberated in Honolulu).

(One shipment).

Onthophagus comperei.

Onthophagus laminatus.

Onthophagus cuniculus—large and small copriid beetles.

(Only one individual of the large species survived, but 140 of the small one, *comperei*, were liberated, in good condition, at Olinda, Maui).

(One shipment).

Onthophagus sp.—a small copriid beetle.

(200 individuals in the shipment, all dead save two).

FROM SOUTHWESTERN STATES AND MEXICO.

(17 shipments).

Copris colonicus—a large copriid beetle.

(15 shipments made, containing in the aggregate over one thousand individuals, which were liberated, in smaller or larger lots, on all of the islands).

Copris remota—a moderately large species.

(9 shipments were made comprising 1500 individuals, which were liberated in larger or smaller lots, on all of the islands except Kauai).

Canthon sp.—a small copriid beetle.

(Sent once. Only a few individuals included in the shipment, which were liberated at Waialae Ranch, Oahu).

Onthophagus sp.—a small species.

(Sent twice, less than 50 individuals received. First lot liberated on the Parker Ranch, second at Olinda).

Onthophagus? sp.—a small dung beetle.

(Sent twice. First lot, comprising 7 individuals, liberated at Waialae; second lot, many individuals included, sent to Parker Ranch).

Phaenius sp.—a moderately large, metallic green copriid beetle.

(Received in small numbers 12 times. 6 liberated on the Waialae Ranch, Oahu; 2 on the Parker Ranch, Hawaii; a few at Kilohana, Kauai, 10 at Olinda, 4 on the Haleakala Ranch, Maui, and 2 at the Cooke Dairy on Molokai).

Phaenius? sp.—a moderately large green species.

(Sent twice. First lot of 240 liberated on the Parker Ranch, Hawaii; second lot of 100 sent to the Cooke Dairy, Molokai).

Hister sp.—a predaceous beetle.

(Sent 5 times. Less than 50 individuals in all received, most of which were liberated at Waialae, Oahu).

Staphylinidae—predaceous beetles.

(One consignment, comprising only a few individuals, which were liberated near Honolulu).

Spalangia sp.—a parasitic chalcid fly.

(Sent once. Failed to multiply in confinement).

Eucoila sp.—a parasitic Cynipid.

(Sent once. Failed to multiply in confinement).

The outcome of these introductions is still uncertain but since some of the tumble-bugs retained for observation eventually rolled balls of manure in which eggs were found about ready to hatch, it is expected that some of the species will be able to increase here. The large Staphylinid (*Creophilus erythrocephala*), brought by Mr. Illingworth from Australia, has already been recovered in Honolulu and is no doubt established.

PINEAPPLE INSECT INVESTIGATIONS.

The pineapple insect investigations had their origin in an outbreak of fruit beetles during the summer harvest of 1921 and were continued after that trouble disappeared on account of the appearance of red spider in the fields on the island of Oahu. Considerable losses were being experienced in September from top-rot in newly planted fields and it was believed that the mite-infested plants were especially susceptible. These plants had come from very old fields and the infestation represented an unusual condition at the time, but one, it is now realized, likely to occur at the height of any summer in old fields, whence the supply of plants is largely drawn. It was particularly desired at the time to know how to cope with red spider, and field experiments were conducted with a variety of insecticides to test their relative effectiveness in checking the development and spread of the mites. While results were awaited from these experiments the fumigation of plant stock was tried, to rid them of mites before they were set out. These preliminary experiments demonstrated the ineffectiveness of fumigation. Neither hydrocyanic acid gas nor carbon bisulphide gas in safe concentrations could be depended upon to kill all the mites on a plant. Later the whole subject of artificial control in relation to pineapple pests was gone into afresh with a comprehensive series of experiments conducted under the auspices of the Hawaiian Pineapple Company on the newly-planted section of their lands at Moanalua. The purpose of the experiments was to test the relative and actual value of insecticidal sprays, dusts and gases as means of controlling infestations of mealy-bug, scale and red spider. Four separate areas were placed at my disposal for the experiments. The largest consisted of an irregular subdivision embracing 84 rows and was utilized for the following tests.

Plat 6, 5 rows, planted with 7 bags of red spider infested plants. The plants put in the westerly two rows had been pre-

viciously fumigated with both hydrocyanic acid gas and carbon bisulphide gas. The plants in the other three rows received no treatment and served as a check. The plants suffered no burning or other ill-effects from the fumigation and grew vigorously upon being set out. No mealy-bugs, scales or mites could be detected on the plants during the first six months of growth, but later mealy-bug infestation was fairly common.

Plat 7, 15 rows planted with scaly plants, 5 westerly rows received no treatment and served as a check. The plants in the other 10 rows were sprayed 5 times at monthly intervals between December 19th and May 12th with kerosene emulsion made from 1 quart kerosene, 1 pint water, 1 ounce ivory soap and diluted with 16 volumes of water. Eight gallons of the mixture were required at each application. Neither mealy-bugs nor scales were prevalent while it was being used, but developed to some extent later. On one occasion the application burned the leaves and caused the loss of a few plants.

Plat 8, 15 rows planted with scaly plants, 5 westerly rows, untreated, check. Other 10 rows of plants treated with commercial tobacco dust 8 times at irregular intervals between December 19th and September 28th. The dust was applied with a patent dusting machine, and $6\frac{1}{4}$ lbs. were required at each application. Neither mealy-bugs nor scale were prevalent during the first six months on the treated plants but the check rows were badly infested. Later, the entire plat became badly infested, particularly with mealy-bugs.

Fourteen rows on the easterly side of the previous experiment were used to test the mixture of tobacco dust and sulphur in equal parts, the westerly 5 rows, the check, not being treated. In this plat the mealy-bug infestation appeared to come from the direction of adjoining weedy pasture land. On one occasion a few plants were burned by some of the sulphur.

Plats 9 and 10, 15 rows planted with scaly plants. Five westerly rows received no treatment and served as a check. The plants in the other 10 rows were sprayed, the 5 westerly rows (9) with a decoction of commercial tobacco scrap (standard strength $\frac{1}{2}$ lb. tobacco to 1 gallon of water, 1 ounce of soap), the 5 easterly rows (10) with a solution of commercial nicotine sulphate or black leaf 40 (standard strength $\frac{1}{8}$ ounce black leaf 40 to 1 gallon of water, 1 ounce of soap), 6 times at monthly intervals between December 20th and June 5th. Neither mealy-bugs nor scale were prevalent during the period

on either treated or untreated plants, but after the lapse of six months many plants bore a heavy infestation.

Plats 11 and 12, 15 rows planted with red spider infested plants; 5 westerly rows received no treatment and served as a check. The other 10 rows were treated with sulphur, the westerly 5 rows (11) with commercial sulphur applied with a patent dusting machine, the easterly 5 rows (12) with commercial lime-sulphur applied as a spray, using 1 ounce (5 teaspoonfuls) to the gallon of water. Four applications were made to 11 between December 20th and April 6th, when the treatment was discontinued on account of burning a number of plants with the sulphur. There were 640 plants in this plat, where the rows were abbreviated by the contour of the field, and the dust was spread over the plants by one man in 10 minutes; $3\frac{3}{4}$ lbs. of sulphur were used at each application. Six applications were made to 12 between December 20th and June 6th. No burning occurred at any time. There were 426 plants in this plat, which was also composed of short rows, and the spray was spread over the plants by one man in 10 minutes. The red spider infestations were apparently of little economic importance after the plants rooted. Some of the plants, however, were severely injured by the spider before being set out. The plants were likewise free of mealy-bugs and scale until the middle of May, when mealy-bug infestation became apparent in the plat nearest the adjoining uncultivated land. Subsequently the infestation became worse as time progressed.

Another area in the northern section of the field was utilized to test the effects of treatment on mealy-bug infestations. This section, planted in September, contained many infested plants when assigned to me for the purposes of the experiment. The area consisted of 30 short rows, which were platted and treated as follows:

Plat 15, 10 rows of plants, the northerly 5 treated with kerosene emulsion as in Plat 7, southerly 5 to check, 6 applications made between December 29th and May 15th when the treatment was discontinued on account of a severe burning which occurred on some of the plants.

Plat 16, 10 rows of plants, northerly 5 treated, southerly 5 check, material used, tobacco decoction or nicotine sulphate in the form of a spray as in Plats 9 and 10 applied 7 times between December 29th and June 5th.

Plat 14, 10 rows of plants, northerly 5 treated, southerly 5

check, material used, commercial tobacco dust as in Plat 8, applied 7 times between December 29th and June 5th.

While it is believed that these treatments kept the infestation from increasing temporarily, their beneficial effects are very little apparent after the lapse of six months. The area, which is already producing fruit, is heavily infested and there is little difference between treated and check rows. Some of the plants showed severe infestations of scale.

Two other areas were used to test the value of fumigation and dipping applied to plant stock as a means of preventing or controlling infestations of mealy-bug and scale.

In the planting done under paper on the easternmost ridge of the Moanalua section in March and April, 6 different lots of plants were set out in separate rows, each lot comprising a limited number of plants, which were used to plant the row as far as they would go, the row then being filled out with untreated check plants. Three lots consisted each of one bag of plants, a fourth a boxful (250 plants), treated with hydrocyanic acid gas, standard strength (made after the 1-1 $\frac{1}{2}$ -2 formula, i. e. 1 part cyanide of potassium, 1 $\frac{1}{2}$ parts sulphuric acid, 2 parts water, using 1 ounce potassium cyanide to every 100 cubic feet air space), the exposure varying as follows: Lot T 18, 15 hours, Lot T 19, 1 hour, Lot T 20, 2 hours, Lot T 21, (250 plants), 1 hour. Another lot, T 22, consisted of 1 $\frac{1}{2}$ bags of plants which had been exposed to carbon bisulphide gas for 1 $\frac{1}{2}$ hours at the concentration formed by $\frac{1}{2}$ ounce carbon bisulphide in 15 cubic feet contained air space through the time specified. Another lot, T 23, consisted of 1 $\frac{1}{2}$ bags of plants which had been dipped in a solution of nicotine sulphate made by dissolving $\frac{1}{4}$ pint commercial nicotine sulphate or black leaf 40 in 25 gallons of water with the addition of 1 lb. of soap. Samples of these different lots were examined in the laboratory with the aid of a microscope at various periods following the treatment and it was discovered that the hydrocyanic acid gas, standard strength, was effective as a lethal agent for both mealy-bugs and scales in whatever stage of development, with both short and long exposure, but neither the carbon bisulphide gas nor the nicotine dip proved effective; in the one case it is believed the gas was generated too slowly to reach all the insects in the specified time; in the other there was an apparent lack of penetration as well as weakness in

the solution; in no case was there any actual or apparent injury to the plants.

In the planting done under paper in April and May, in the last portion of the section to be planted about 51 rows, T 25, were set out to plants fumigated in the field immediately before planting. Two portable fumigating boxes were used, holding about 150 to 200 plants each, the lethal agent being hydrocyanic acid gas, standard strength, developed as above described, exposure 1 hour's duration. It was found possible thus with two men, loading, unloading and charging the fumigating boxes from piles of plants deposited at the line of planting, to keep a gang of five planters constantly supplied with clean plants. Larger planting gangs could be supplied by using additional boxes.

All of these plants and their checks were carefully examined eight months subsequent to the planting and certainly little difference could be observed between the treated and untreated plants with regard to mealy-bug infestation, although no heavy infestation of scale could be observed.

The conclusion reached from a study of the results obtained from this experimental work are that an effective control of the prevailing pineapple pests cannot be expected from the use of artificial methods, even from repeated applications of insecticides, which would be too expensive for general adoption; their use would therefore seem to be limited to outbreaks or unusual conditions, particularly where small areas of plants are affected and it is believed a normal condition can be restored by a single or a few applications. The unsatisfactory results obtained from artificial methods of control emphasized the importance of investigating the possibilities contained in the biological method, and a beginning has been made in this direction in connection with the introduction of mealy-bug enemies, as later detailed.

MEALY-BUG CONTROL.

The mealy-bug investigations grew out of our explorations in Southwestern United States and Mexico for horn-fly enemies. Mr. Osborn was instructed while collecting dung beetles in Mexico—an occupation which left him a considerable degree of leisure—to investigate the possibility of securing enemies of several of our most prevalent mealy-bug species supposed to be indigenous in that region, particularly a species of lady beetle

(*Hyperaspis silvestri* Coccinellidae), Pl. XI, which previous collectors in that region had observed to be an effective enemy of the avocado mealy-bug *Pseudococcus nipae*. This species infests a variety of economic plants (avocado, fig, palms, guava, etc.) and has proved a great handicap to horticultural operations, being scarcely at all or only with great difficulty controlled by sprays, dusts or fumigation. While collecting this insect to ship to Hawaii, Mr. Osborn discovered that the mealy-bug referred to had other enemies, namely, two other lady beetles and three different parasites. All these species were shipped in sizable lots to Hawaii and were handled here by Mr. Timberlake, Assistant Entomologist of the H. S. P. A. Experiment Station, and myself in the quarantine room of the Planters' Experiment Station, according to the requirements of each individual shipment as to safety from undesirable inclusions and most promising means of early establishment. As Mr. Osborn's collecting and investigation progressed, other desirable species were discovered and experimented with, notably a lady-beetle and parasite of the sugar cane mealy-bug (*Pseudococcus calceolariae*) and a lady-beetle and parasite of the pineapple mealy-bug (*Pseudococcus bromeliae*). After making several consignments of *nipae* enemies he began shipping the cane benefactors, which were handled in a similar manner. Then, as funds with which to continue the work became low, the pineapple growers were appealed to for support, and \$1,500 were contributed by the Packers' Association to secure the enemies of the pineapple mealy-bug. Later, a coöperative arrangement was made between the H. S. P. A. and the Board to keep Mr. Osborn in the Mexican field on various problems, particularly the investigation of cutworm and wireworm enemies. Mr. Osborn has made altogether 16 shipments of material. The species handled thus far have been:

PSEUDOCOCCUS NIPAE ENEMIES.

- Allotropa* sp. (Platygasteridae) on *P. nipae* (buff species) with guava leaves. 2 shipments, producing 475 females, 353 males which were liberated in sizable lots on *P. nipae* at various points in Honolulu.
- Gyranusa* spp. (Encyrtidae) on *P. nipae* (buff species) and *Pseudococcus* sp. (white species) with guava leaves. 2 shipments producing 74 females, 16 males, which were liberated in sizable lots on *P. nipae* at various points in Honolulu.
- Pseudaphycus* sp. (Encyrtidae) Pl. XI, on *P. nipae* with guava leaves. 1 shipment producing 23 females, 26 males, which were liberated in sizable lots on *P. nipae* originally at three points in Honolulu.

Pseudaphycus sp. (Encyrtidae) small, on *P. nipae* (buff species) with guava leaves. 1 shipment producing only a few individuals, which were held for rearing without result.

Scymnid (Coccinellidae) 4-spotted, on *P. nipae* (buff species) with guava leaves. 1 shipment producing only a few individuals with were held for rearing, and have gone through one generation without multiplying.

Hyperaspis silvestri (Coccinellidae) as larvae. Pl. XI. 2 shipments, producing 289 adults. Part of the lots was liberated and part retained for multiplication. See record of distribution which follows:

Hyperaspis sp. (Coccinellidae) as larvae. Beetle with 2-spotted elytra. 1 shipment producing 27 adults. Retained for multiplication.

Curinus coeruleus (Coccinellidae), Pl. XI, as larvae. 2 shipments, producing 37 adults. Part of the lots was liberated and part retained for multiplication. See record of distribution which follows:

Also incidental predators, including 3 individuals of a Syrphid fly (*Bacca* sp.), 7 individuals of an Agromyzid fly (*Leucopis* sp.) and 8 individuals of a Hemerobiid lacewing fly, which were liberated at one point in Honolulu.

PSEUDOCOCCUS CALCEOLARIAE ENEMIES.

nr. *Chrysoplaterus* sp. (Encyrtidae) on *P. calceolariae* with leaves of grass. 7 shipments producing 123 males and females. Part of the lots was liberated at two points in Honolulu and part retained for multiplication.

This species also reared experimentally on *P. sacchari*, *P. kraunhiae*, *P. longispinus* and *P. lounsburyi*.

Diomus sp. (Coccinellidae) with velvety-brown larvae. 5 shipments producing 366 adults. Part of the lots was liberated and part retained for multiplication. See record of distribution which follows:

This species also reared on *P. sacchari* and *P. bromeliae*.

PSEUDOCOCCUS BROMELIAE ENEMIES.

Pseudaphycus sp. (Encyrtidae) small species, on *P. bromeliae* with pieces of pineapple. 3 shipments. Held for rearing without result.

Nephus sp. (Coccinellidae) Scymnid with reddish spot on elytron and mealywhite wax covered larvae. 9 shipments producing 10 individuals. Retained for multiplication. See record of distribution which follows.

Also reared on *P. kraunhiae*, *P. longispinus* and *P. calceolariae*.

? (Encyrtidae) metallic with obscure axillae. 3 shipments on bromeliaceous plants. Held for rearing without result.

Diomus sp. (Coccinellidae) Scymnid with reddish striped elytra and velvety brown larvae. One shipment producing 24 adults. Retained for multiplication.

ARMY WORM CONTROL.

The army worm project has not progressed far enough to justify a report, except to mention the introduction of 3 female and 4 male birds of an Australian species known as the Pewee lark (*Grallina picata*) in June of 1922. These birds were the survivors of an original lot of 35 gathered in Australia and brought hither by the animal collector Josephs, and were pur-

PLATE XI

ENEMIES OF THE AVOCADO MEALYBUG



1. *Curinus coeruleus*—Adult beetle; 1a larva
2. *Pseudaphycus* sp.—Adult
3. *Hyperaspis silvestri*—Adult beetle; 3a larva
4. Leaf with eggs and larvae—natural size.

chased for the Parker Ranch and liberated near Kamuela by Dr. J. F. Illingworth, who became familiar with its good qualities by a residence of three years in Australia, and recommended its introduction to the Board. The Board's approval of this and other species opens a new field to exploration, in our effort to secure valuable predatory animals.

MISCELLANEOUS WORK.

Assistance was given to the Federal Entomologist in Hawaii in introducing and colonizing additional parasites of the bean weevils. A detailed account of this work appeared in the Hawaiian Forester and Agriculturist for September, 1921. Three of the species introduced at that time are now known with certainty and the fourth doubtfully to be established, and their presence will help materially to reduce the infestation of our bean crop by weevils.

The establishment of one of the pupal parasites of the fruit fly introduced by Dr. Silvestri in 1914 was also ascertained recently.

During the past year the fern weevil has been discovered in two new localities, viz., the ditch country, on Maui, and along the roads to Kapoho and Kalapana directly beyond Pahoia. These regions will be stocked with the parasite of the weevil introduced from Australia.

* PUBLICATIONS.

The following publications have been made:

The Fern Weevil (*Syagrius fulvitaris* Pasc.)

Hawaiian Forester and Agriculturist XVIII (5), pp. 101-114 Pl. I, May, 1921.

Fig Insect Investigations.

Hawaiian Forester and Agriculturist XVIII (6), pp. 139-143, June, 1921.

Horn Fly Control.

Hawaiian Forester and Agriculturist XVIII (10), pp. 219-21 Pl. I, October, 1921.

Notes on Immigrant Coleoptera.

Pr. Haw. Ent. Soc. 1921, Vol. V, No. 1, pp. 75-82, October, 1922.

Notes on the Mealy-bugs of Economic Importance in Hawaii. (In the press).

Respectfully submitted,

DAVID T. FULLAWAY,

Entomologist.

TABULATION

SHOWING THE LIBERATION OF BENEFICIAL INSECTS, 1921-1922.

	Oahu	Kauai	Molokai	Maui	Hawaii	Total
FRUIT FLY						
PARASITES*						
<i>Tetrastichus giffardianus</i>	32,650	....	500	3,000	600	36,750
<i>Diachasma fullawayi</i>	10,900	....	300	840	....	12,040
<i>Diachasma tryoni</i>	17,392	....	300	1,125	430	19,247
<i>Opius humilis</i>	4,140	....	200	150	....	4,490
<i>Dirhinus giffardi</i>	9,150	....	....	250	700	10,100
<i>Galesus silvestri</i>	9,200	....	....	350	....	9,550
	83,432	1,300	5,715	1,730	92,177

MELON FLY

PARASITE.†

<i>Opius fletcheri</i>	46,770	5,200	400	3,625	1,200	57,195
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CORN-LEAF-HOPPER

PARASITE.‡

<i>Paranagrus osborni</i>	1,800	1,000	4,700	7,500
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*Liberated at:

Oahu: Honolulu, Pearl City, Maunawai, Waipahu.*Maui*: Wailuku, Kula, Paia.*Hawaii*: Kohala, Kailua.

†Liberated at:

Oahu: Honolulu, Pearl City, Wahiawa, Maunawai, Waianae.*Maui*: Kihei, Makawao, Paia, Kaapo.*Hawaii*: Kamuela, Keaau.*Kauai*: Kealia, Lihue, Kapaa.*Molokai*: Kaunakakai.

‡Liberated at:

Oahu: Honolulu, Kaneohe.*Hawaii*: Waiohinu, Keaau, Kohala, Pahala, Holualoa, Kealahakua.*Maui*: Kihei, Wailuku.

	Oahu	Kauai	Molokai	Maui	Hawaii	Total
FERN-WEEVIL						
PARASITE.§						
<i>Ischiogonus syagrii</i>	50	....	....	100	150	300
DUNG-FLY						
PREDATOR.¶						
<i>Philonthus erythrocephala</i>	13,158	460	900	1,770	1,090	17,378
MEALY-BUG						
PARASITES.||						
<i>Pseudaphycus</i> sp.	27	....	....	8	....	35
<i>Chrysoplatycerus</i> sp.	600	....	....	....	....	600
Total.....	627	....	....	8	....	635

MEALY-BUG

PREDATORS.°

<i>Hyperaspis silvestri</i>	288	....	....	24	....	312
<i>Curinus coeruleus</i>	1,391	....	....	50	....	1,441
<i>Diomus</i> sp.	600	....	....	....	....	600
<i>Nephus</i> sp	2,690	....	....	200	....	2,890
Total.....	4,969	....	....	274	....	5,243

§Liberated at:

Oahu: Tantalus, Moanalua.*Hawaii*: Kilauea, Hilo, Kapoho.*Mau*i: Oopula, Nahiku, Keanae.

¶Liberated at:

Oahu: Waiālae, Moanalua, Manoa, Waikiki.*Kauai*: Kilohana.*Molokai*: Kaunakakai.*Mau*i: Makawao, Wailuku.*Hawaii*: Waimea.

||Liberated at:

Oahu: Manoa, Makiki.*Mau*i: Haiku.

°Liberated at:

Oahu: Honolulu, Moanalua, Puuloa, Pearl City, Kemoo, Kipapa, Kapalama, Makiki, Kaimuki, Manoa, Waikiki.*Mau*i: Haiku.

TABULATION

SHOWING REARING, LIBERATION AND DISTRIBUTION OF
PTEROMALUS PUPARUM, PUPAL PARASITE OF THE
CABBAGE BUTTERFLY, PIERIS RAPAE,

1921-1922.

Month	Pupae	Emergence	Liberation
1921			
January	100	1,837	1,150
February	108	2,579	1,300
March	119	2,535	2,150
April	97	2,978	2,150
May	29	2,215	1,050
June	15	570	200
July	19	1,025	....
August	44	2,240	1,800
September	53	1,423	2,200
October	20	1,244	1,150
November	28	1,456	1,000
December	8	1,280	1,200
Total.....	640	21,382	15,350
1922			
January	109	560	700
February	90	1,695	1,100
March	23	964	450
April	15	465	300
May	13	430	250
June	21	478	500
July	24	915	250
August	13	725	650
September	12	315	250
October	13	405	....
November	21	745	300
December	18	1,005	350
Total.....	372	8,702	5,100
Total for 1921-1922.....	1,012	30,084	20,450

Liberated at the following localities:

Oahu: Moiliili, Moanalua, Nuuanu, Kaimuki, Kalihi, Makiki, Wahiawa, Pearl City, Waikiki.*Molokai*: Kaunakakai.

TABLE

SHOWING TOTAL PARASITISM OF ALL LARVAE OF THE MEDITERRANEAN FRUIT FLY (*CERATITIS CAPITATA*)
COLLECTED IN HAWAII DURING 1918, ARRANGED
BY MONTHS.

(Copied from Journal of Agricultural Research, Vol. XVIII, (8), p. 445)
Percentage of parasitism.

Month	Number of larvae.....	<i>Opus humilis</i>	<i>Diachasma tryoni</i>	<i>Diachasma fullawayi</i> ...	<i>Tetrastichus giffardianus</i> .	Total for 1918.....	Total for 1917.....	Total for 1916.....
January	5,219	4.8	9.6	6.2	0.8	21.4	59.0	6.98
February ...	3,600	2.3	2.5	1.6	.2	6.6	32.9	19.5
March	4,404	24.1	7.9	2.3	3.2	37.5	63.5	14.7
April	4,675	10.3	27.8	5.0	.4	43.5	43.3	37.64
May	5,854	16.5	17.3	.2	2.0	36.0	40.9	26.69
June	14,388	11.8	48.6	.8	3.7	64.9	36.1	27.81
July	8,827	2.0	52.2	2.1	3.6	59.9	51.0	18.52
August	4,850	.7	38.1	3.8	7.9	50.5	33.1	37.5
September ..	4,471	2.4	28.0	3.4	13.3	47.1	52.4	45.2
October	6,885	6.5	22.0	3.2	.4	41.1	45.2	44.3
November ...	8,659	25.3	21.7	.5	11.2	58.7	72.3	44.3
December ...	1,648	21.5	37.7	.4	10.9	70.5	34.2	44.1
Average for 1918.....	63,480	12.4	34.6	2.6	6.2	55.8	...	....
Average for 1917.....	72,139	12.7	20.3	7.3	7.2	...	47.5	....
Average for 1916.....	83,304	17.2	13.3	2.1	.6	...	...	33.2

Board of Agriculture and Forestry

PUBLICATIONS FOR DISTRIBUTION, 1923.

Any one or all of the publications listed below (except those marked*) will be sent to residents of this Territory, free, upon application to Mailing Clerk, P. O. 3319, Honolulu, Hawaii.

BOARD

- *Reports of the Commissioner of Agriculture and Forestry for 1900 and 1902, and First Report of the Board of Commissioners of Agriculture and Forestry, 1904. Reports of the Board of Commissioners of Agriculture and Forestry for the years 1905, 1906, 1907, 1908, and biennial periods 1910, 1912, 1914, 1916, 1918, 1920, and 1922.
- "Notice to Importers," by H. E. Cooper; 4 pp.; 1903.
- "Digest of the Statutes Relating to Importation of Soils, Plants, Fruits, Vegetables, etc., into the Territory of Hawaii." General Circular No. 1; 6 pp.
- "Important Notice to Ship Owners, Fruit Importers, and Other Rules and Regulations Prohibiting the Introduction of Certain Pests and Animals into the Territory of Hawaii." General Circular No. 2; 3 pp.; 1904.
- "Laws and Regulations, Importation and Inspection of Honey Bees and Honey." General Circular No. 3; 7 pp.; 1908.
- Act 71, Session Laws of 1905: "To Provide for the Protection of Forest Land Within the Territory from Fire." On Brush-Burning Permit Form; 1905.
- Act 104, Session Laws of 1907: "To Provide for the Protection of Birds Beneficial to the Forests of the Territory of Hawaii." Unnumbered leaflet; 1907.
- Pure Seed Law, Act 107, Session Laws of 1911: "To Regulate the Importation and Sale of Seed Into and Within the Territory of Hawaii." Unnumbered leaflet, 4 pp.; 1911.
- "The Hawaiian Forester and Agriculturist," a monthly magazine. Vols. I to XIX; 1904-1922. To be obtained from the Advertiser Publishing Co., Ltd., Honolulu, Hawaii. Price, \$1.00 a year. (Issued under the auspices of the Board.)

DIVISION OF FORESTRY

- "Eucalyptus Culture in Hawaii," by Louis Margolin. Bulletin No. 1; 88 pp.; 12 plates; July, 1911.
- "An Offer of Practical Assistance to Tree Planters." Circular No. 1; 6 pp.; 1905.
- "Instructions for Propagating Forest, Shade and Ornamental Trees," by David Haughs; Circular No. 2; 11 pp.; June, 1912. Reprinted, May, 1915.
- **"Forest and Ornamental Tree Seed for Sale at Government Nursery." Press Bulletin No. 1; 3 pp.; 1905.
- "Suggestions in Regard to the Arbor Day Tree Planting Contest." Press Bulletin No. 2; 7 pp.; 1905.
- "Revised List of Forest and Ornamental Tree Seed for Sale at the Government Nursery." Press Bulletin No. 3; 4 pp.; 1906.
- "Instructions for Propagating and Planting Forest Trees." Press Bulletin No. 4; 4 pp.; 1906.
- "Instructions for Planting Forest, Shade and Ornamental Trees." Press Bulletin No. 5; 7 pp.; 1909.
- "Na Hoakaka no ke Kanu ana i na Laau Hoomalu ame na Laau Hoohiwahiwa." Press Bulletin No. 6; 8 pp.; 1909.
- Rule II: "Concerning the Protection and Administration of Forest Reserves"; unnumbered leaflet; April, 1916.
- Rule III: "Concerning Trespassing on the Honolulu Watershed"; unnumbered leaflet; April, 1916.
- Rule IV: "Concerning the Protection of Bird, Animal and Vegetable Life on Certain Islands of the Territory"; unnumbered leaflet; July, 1917.
- "Forestry as Applied in Hawaii," by C. S. Judd. Reprint from "The Hawaiian Forester and Agriculturist," Vol. XV, No. 5; 17 pp.; 4 plates; May, 1918.
- Rule V: "Concerning the Protection of the Palolo-Manoa Drainage Reservation," unnumbered leaflet; May 13, 1922.
- Reports of the Division of Forestry for the years ending December 31, 1905, 1906, 1907, 1908, and biennial periods 1910, 1912, 1914, 1916, 1918, 1920, and 1922.

Botany

- **"New and Noteworthy Hawaiian Plants," by Dr. L. Radlkoffer and J. F. Rock. Botanical Bulletin No. 1; 15 pp.; 6 plates; September, 1911.
- "List of Hawaiian Names of Plants," by J. F. Rock. Botanical Bulletin No. 2; 20 pp.; June, 1913.
- "The Sandalwoods of Hawaii," by J. F. Rock. Botanical Bulletin No. 3; 43 pp.; 13 plates; December, 1916.
- "The Ohia Lehua Trees of Hawaii," by J. F. Rock. Botanical Bulletin No. 4; 76 pp.; 31 plates; August, 1917.
- "The Aborescent Indigenous Legumes of Hawaii," by J. F. Rock. Botanical Bulletin No. 5; 53 pp.; 18 plates; June, 1919.
- "The Hawaiian Genus *Kokia*, A Relative of the Cotton," by J. F. Rock. Botanical Bulletin No. 6; 22 pp.; 7 plates; June, 1919.

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PUBLICATIONS FOR DISTRIBUTION - (Continued).

DIVISION OF ENTOMOLOGY

- "The Leaf-Hopper of the Sugar Cane," by R. C. L. Perkins. Bulletin No. 1; 38 pp.; 1903.
- †"A Catalogue of the Hemipterous Family Aleyrodidae," by G. W. Kirkaldy and "Aleyrodidae of Hawaii and Fiji with Descriptions of New Species," by Jacob Kotinsky. Bulletin No. 2; 102 pp.; 1 plate; 1907.
- "Report of an Expedition to Africa in Search of the Natural Enemies of Fruit Flies," with Descriptions, Observations and Biological Notes, by F. Silvestri. Bulletin No. 3; 176 pp.; 26 plates; 1914.
- "The Corn Leaf Hopper," by D. T. Fullaway. Bulletin No. 4; 16 pp.; 18 figs; 1918.
- *"On Some Diseases of Cane Specially Considered in Relation to the Leaf Hopper Pest and to the Stripping of Cane," by R. C. L. Perkins. Press Bulletin No. 1; 4 pp.; 1904.
- "A Circular of Information," by Jacob Kotinsky. Circular No. 1; 8 pp.; 1905.
- *"The Japanese Beetle Fungus," by Jacob Kotinsky and Bro. M. Newell. Circular No. 2; 4 pp., cuts; 1905.
- "Mediterranean Fruit Fly (*Ceratitis capitata*)," by E. M. Ehrhorn. Circular No. 3; 7 pp.; 2 plates; 1912.
- "The Fern Weevil," by D. T. Fullaway. Reprint from May, 1921, "Forester"; 13 pp.; 1 plate.
- Reports of the Division of Entomology for the years, ending December 31, 1905, 1906, 1907, 1908 and biennial periods 1910, 1912, 1914, 1916, 1918, 1920, and 1922.

DIVISION OF PLANT INSPECTION

- Rule I: "Concerning the Importation of Fruits, Plants, etc." Unnumbered leaflet; Amended June 8, 1918; further amended, October 31, 1919, further amended, March 24, 1921.
- Rule III: "Concerning the Importation of Rice." Unnumbered leaflet, amended June 8, 1918.
- Rule VII: "Concerning the Prevention of Distribution of the Mediterranean Fruit Fly." Unnumbered leaflet; November 21, 1910.
- Rule VIII: "Concerning the Importation of All Banana Fruit, Shoots or Plants." Unnumbered leaflet; January 25, 1911.
- Rule IX: "Concerning the Prevention of Distribution of Insect Pests from Oahu to the Other Islands." Unnumbered leaflet; June 28, 1911.
- Rule XII: "Concerning the Control of Insects and Plant Diseases in the Territory of Hawaii." Unnumbered leaflet; December 30, 1911; amended May 26, 1920.
- Rule XVIII: "Concerning the Control of Fungus Diseases on Pineapples, Island of Kauai." Unnumbered leaflet; May, 1913; amended to include Island of Oahu; June, 1914; amended further on September 2, 1916; amended further July 18, 1919.
- Rule XIX: "Concerning the Introduction of Pineapple Plants, etc." Unnumbered leaflet; June 8, 1918.
- Rule XX: "Concerning the Control of Insect Pests and Plant Diseases." Repealing Rule XVII. Unnumbered leaflet; June 1, 1919; amendment to Section 5, June 1, 1920.
- Rule XXI: "Concerning the Control of Certain Insect and Plant Pests." Unnumbered leaflet; February 25, 1920; amended May 7, 1920.
- Rule XXII: "Concerning the Importation into the Territory of Hawaii of Potatoes and Apples from Pacific Coast Ports." Unnumbered leaflet, May 26, 1920.
- Reports of the Division of Plant Inspection for the biennial periods 1918, 1920 and 1922.

DIVISION OF ANIMAL INDUSTRY

- *"Inspection of Imported Live Stock" Rule I; 1 p.; 1905.
- *"Inspection and Testing of Imported Live Stock for Glanders and Tuberculosis." Rule 2; 1 p.; 1905.
- *"Concerning Glandered Horse Stock in the Territory." Rule 3; 1 p.; 1905.
- *"To Amend Rule 1, Inspection of Imported Live Stock." Rule 4; 1 p.; 1907.
- *"Quarantine of Horse Stock from California." Rule 8; 1 p.; 1908.
- "Rules and Regulations, Inspection and Testing of Live Stock Intended for importation." Rules I to V and Laws; 11 pp.; unnumbered pamphlet. Effective January 1, 1910; replaces earlier rules.
- Rule VI: "Concerning the Quarantine of Dogs for Rabies"; 2 pp.; unnumbered leaflet; 1912.
- Rule VII: "Concerning the Shipment of Hogs from the Island of Oahu to any Other Island in the Territory of Hawaii"; unnumbered leaflet; July, 1913.
- Rule IX: "Concerning Hog Cholera and Other Diseases of Swine." unnumbered leaflet; August, 1916.
- "The Treatment and Prevention of Sore-Head, or Chicken Pox, by Means of Vaccination," by V. A. Norgaard. Circular No. 1; 5 pp.; February, 1916.
- "Regulations Governing the Importation of Live Stock and other Animals into the Territory of Hawaii." (Rules I-X). Effective June 8, 1918. Circular, 9 p.
- Rule VIII amended November 6, 1920. Rule VII amended February 11, 1921.
- Rule XIV: "Concerning Inter-Island Shipment of Dairy Cattle Affected Tuberculosis." Effective February 25, 1920.
- "Regulations Governing the Inspection and Quarantine of Horses, Cattle, Goats, Swine and Other Animals Imported into the Territory of I. D. A. I Order 1 (Regs. 1 to 17), July 21, 1921. Reg. 9 amended March 30, 1922.
- "Regulations Governing the Tuberculin Testing of Animals, etc." D. A. I Order 1, March 30, 1922.
- Reports of the Division of Animal Industry for the years ending December 31, 1906, 1907, 1908, and biennial periods 1910, 1912, 1914, 1916, 1918, 1920, and 1922.

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